Detectors and Sensors

General Issues for Detectors

- Need to consider system issues
- Optics can also play a role but don’t seem to be covered
  - coatings that degrade
  - liquid crystals
- New detector materials should be looked at by the materials group
- May need to fly effectometers with science detectors for maximum benefit

What is a Detector?

- Measures photons, particles or fields
- Includes:
  - Sensor
  - Front end electronics
  - A/D
  - May include on-chip processing
- Several types
  - Effectometers measure effects of solar variability
  - Science detectors both to study sun and earth and for other appications (i.e., astonomy)
- Other
  - Strategic
  - Aviation
  - Station/shuttle sensors
  - Spacecraft

SET Detector Applicability Matrix (1 of 3)

Detector Class	Detector Type	Subtype	Identified as SET Candidate?	Presentation/ Product Description
y-ray	several	—	No	No
X-ray	CCD	—	Possible	No
	MCP-based	—	No	
	calorimeters/ s/c	—	No (Maybe long term)	
EUV	Image Intensifier/MCP	—	No	No
	Superconducting	STJ/TES	No (Maybe long term)	No
UV	CCD	—	Possible	No
	GaN	—	No (Maybe long term)	
	Si Photodiode	—	Possible	
	Image Intensifier/MCP	—	No	
VIS	CCD	N-channel P-channel s-doped mini-channels OTCCDS	Yes	Yes

SET Detector Applicability Matrix (2 of 3)

Detector Class	Detector Type	Subtype	Identified as SET Candidate?	Presentation/ Product Description
VIS	CMOS	APS	Yes	Yes
		Hi Visi	Yes	
		HIT	Yes	
		SOI, SOS	Yes	
IR	Quanumdots	—	No	No
	µbolometer	—	No	No
	Thermopile	HgCdTe	Yes	Yes
		InSb		
		InGaAs		
		Si:As, Si:Sb, Si:Ge		
		QWIP		

SET Detector Applicability Matrix (3 of 3)

Detector Class	Detector Type	Identified as ET Candidate?	Presentation/ Product Description
Electrons	MCP-based	Yes	Yes
Low energy protons	MCP-based	Yes	Yes
Neutrals + ions	MCP-based	Yes	Yes
High Energy Protons		Yes	Yes
Neutrons	New Techniques	?	?
E Field	Booms	Yes	See other area (booms)
B Field	Magnetometers	?	No

Living with a Star: Space Environment Testbeds
Director Technology

Type of Detector: Solar Pointing Sensor	**Title:** Si Radiation Sensor
Background: *No more than 5 sentences here….*Solar sensor based on standard Integrated circuit (IC) technology. Device uses a novel approach to device fabrication to produce a theoretical pointing accuracy of 0.2 arc sec (1 - 2 arc sec is practical performance expectation). Device is significantly smaller than current state of the art devices.	
Description of Technology Requirements for On-orbit Testing: *No more than 5 sentences here….* On-orbit testing is required to validate pointing accuracy. Space is also required to characterize bias currents generated by photo diodes form solar radiation not filtered by Earth's atmosphere. Radiation effects on device performance and life time also need to be quantified. Biasing by other luminaries (i.e. Earth, Moon) also need to be characterized.	
Timeframe Technology is Needed: 2003 **Timeframe for Technology Maturity:** 2003	**Benefiting Mission(s):** Any mission requires accurate location of solar disc. **Benefits to LWS Applications Areas:** Solar Studies
Flight Requirements: *(if known)* **Orbit:** no preference **Altitude:** **Inclination:** **Power:** <1mW **Weight (kg):** =1e gm **Size (cm):** 1 x 1 x 1 **Telemetry:** < 1 upbs **Environment Measurement:** Solar Pointing Radiation Effects	Name: Michael Watson Phone: (256) 544-3186 Email: mike.watson@msfc.nasa.gov Organization: NASA/MSFC/MS EDIZ

Living with a Star: Space Environment Testbeds
Director Technology

Type of Detector: Low energy charged particle	**Title:** Highly miniaturized sensor for ions or electrons

Background: *No more than 5 sentences here….* Sensor will characterize plasma environment in ionosphere or magnetosphere both for science as well as other flight test can be used to determine S/C potential. Development is based on Cassine + OS-1 designs. Need space environment for full qualification.

Description of Technology Requirements for On-orbit Testing: *No more than 5 sentences here….* Equipotential S/C if possible

Timeframe Technology is Needed: 2004/2005 **Timeframe for Technology Maturity:** 2003, TRL: 3/4	**Benefiting Mission(s):** MMS, Constellation **Benefits to LWS Applications Areas:** S/C environment
Flight Requirements: *(if known)* **Orbit:** LEO to Geosych. **Altitude:** **Inclination:** any **Power:** <1.5 W **Weight (kg):** 0.25 **Size (cm):** 3.5 dia x 10 **Telemetry:** **Environment Measurement:** Provided by detector	Name: Raymond Goldstein Phone: (210) 522-6223 Email: rgoldstein@swri.edu Organization: Southwest Research Institute

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Type of Detector: Si Dosimeter + LET Spectrometer	**Title:** Dosimetry Intercomparison and Miniaturization Experiment (DIME)

Background: *No more than 5 sentences here….*This will be a collaboration of 6 laboratories with at least 4 detector systems. Provides dosimetry from N rad. to M rad. with a mix of proven naval technologies. All dosimeters should be miniaturized, low power, and available after flight through industrial partners. System on a chip architecture employed. Usefull to predict SEE and TID in microelectronics and risk in humans.

Description of Technology Requirements for On-orbit Testing: *No more than 5 sentences here….* Minimal telemetry temperature measurements. System CPU must read digitized output from each instrument.

Timeframe Technology is Needed:	**Benefiting Mission(s):** Any requiring radiation monitoring
Timeframe for Technology Maturity: 2 - 4	**Benefits to LWS Applications Areas:** Microelectronics + Astronaut

Flight Requirements: *(if known)*

Orbit: Elliptical (transfer) or polar orbit preferred

Altitude:

Inclination:

Power:

Weight (kg):

Size (cm):

Telemetry:

Environment Measurement: Radiation and LET Spectra

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Organization: Clemson University

Living with a Star: Space Environment Testbeds
Director Technology

Type of Detector: Gen 2 CMOS Active Pixel Sensor	**Title:** On-Orbit Val of Next Generation, Ultra-Low Power, Highly Integrated, & Rad Hard CMOS Active Pixel Sensor (APS) Detectors

Background: JPL has designed, fabricated and characterized a new generation of high yield, low cost, 512x512 ultra-low power prototype imagers with improved performance: 1.5 linearity INL>78dB dynamic range, QE>53%, blooming immune, 4 - 10 electron read noise, digital (10bits) and analog (<13bits) outputs, that provide data efficient windowing, high frame rate as well as even driven on-chip processing and target tracking. Rad Hard CMOS(256x256) imagers have achieved >5MRad gamma 1.2E12 proton @ 63MeV that continue to image well even at ~77K. We need on-orbit validation for their low risk inclusion in robust LWS instrument (ie. We have been teaming on GFSC Phoenix coronagraph/Solar-B. Imaging Magnetosphere/Solar Physics. NCAR High Altitude Observatory LOS magnetograph, Solar Sail boom and antenna deployment low cost chip cameras).

Description of Technology Requirements for On-orbit Testing: Realistic long term full angle and energy spectrum of all particle types in that On-Orbit environment and well as operational temperatures that are anticipated to be encountered over the life of the LWS missions planned

Timeframe Technology is Needed: LWS mission schedule **Timeframe for Technology Maturity:** Now	**Benefiting Mission(s):** Solar Sail, GAMS, SDO, Solar Sentinel, Far Side Observer, Coronagraph Vector magetographs, Smart Hybrid IR-UV sensors **Benefits to LWS Applications Areas:** Robust, RH Ultra Low-Power/Low Cost, FPA detectors for high performance miniaturized sensors
Flight Requirements: *(if known)* **Orbit:** MEO or GEO transfer to accumulate dose **Altitude:** 1,500Km to 36,000Km **Inclination:** TDB **Power:** ~1-2w **Weight (kg):** ~1-3Kg **Size (cm):** 30x30x90 **Telemetry:** TDB **Environment Measurement:** TDB	Name: Robert Stirbl Phone: (818) 635-6793 Email: robert.stirbl@jpl.nasa.gov Organization: JPL